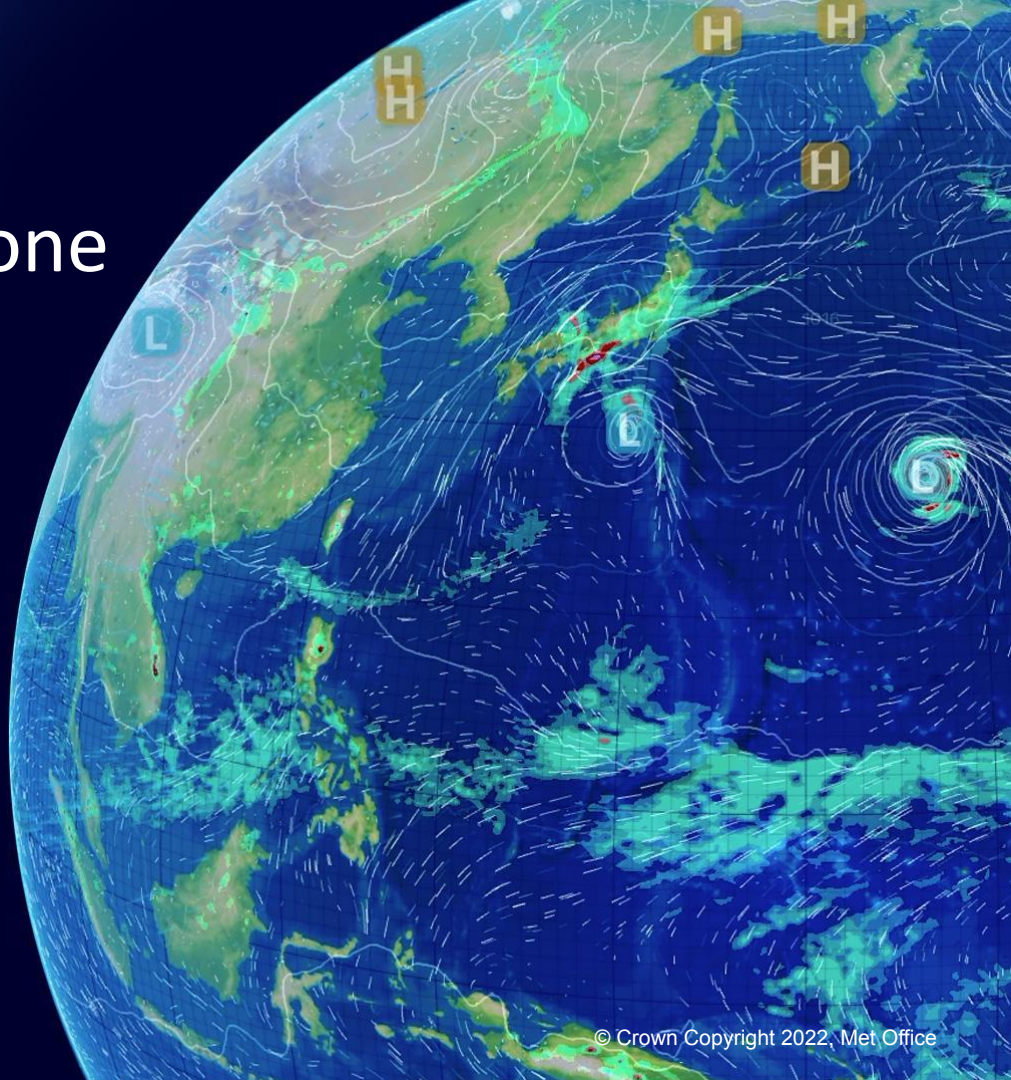
Met Office Tropical Cyclone Modelling Update

TCORF 10 March 2022

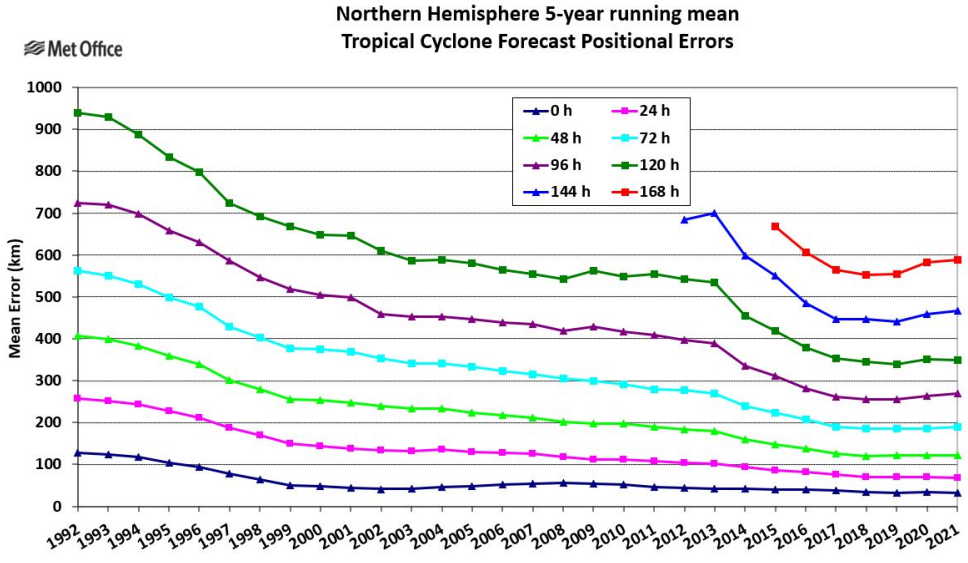
Julian Heming

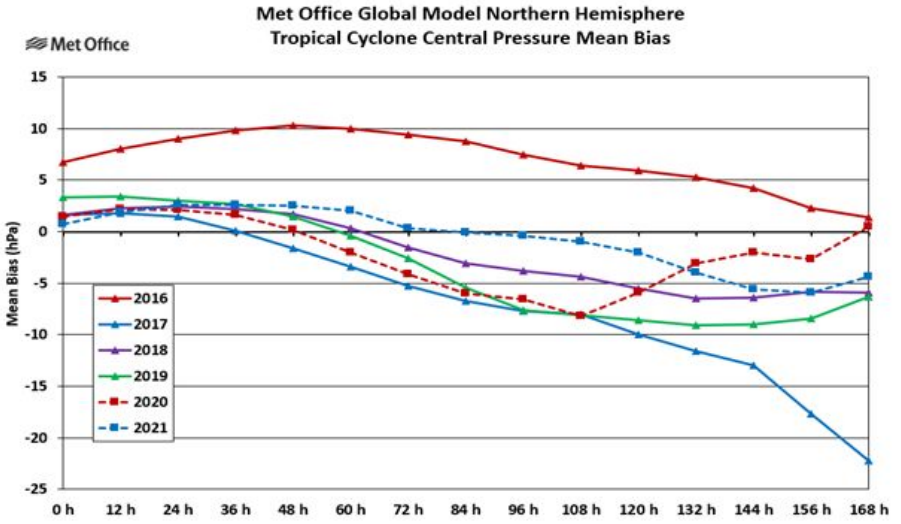


© Crown Copyright 2022, Met Office

Global Model Performance 2021

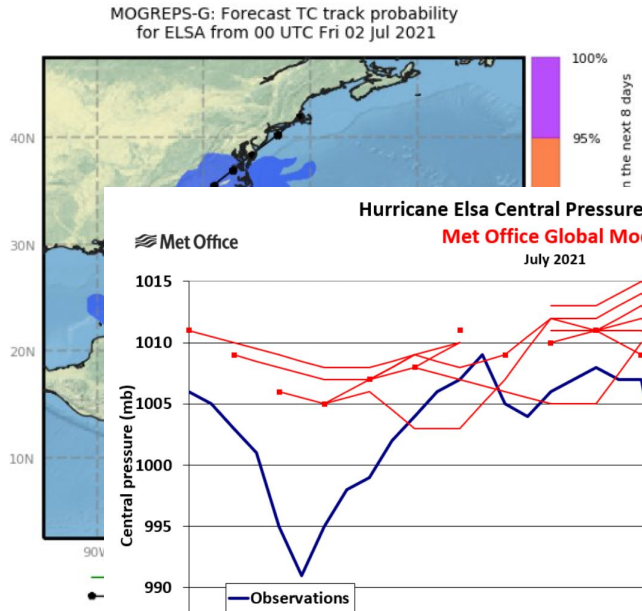
- Northern hemisphere track error on lower than 2020
- Step reduction in 2014 now dropped out of 5-year running mean
- Recent model changes no significant impact on track error
- Intensity biases and errors similar to recent seasons



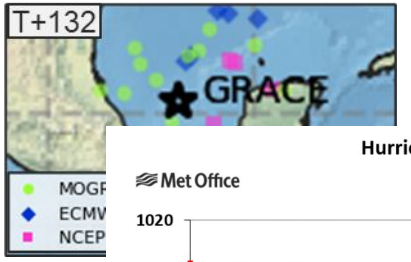


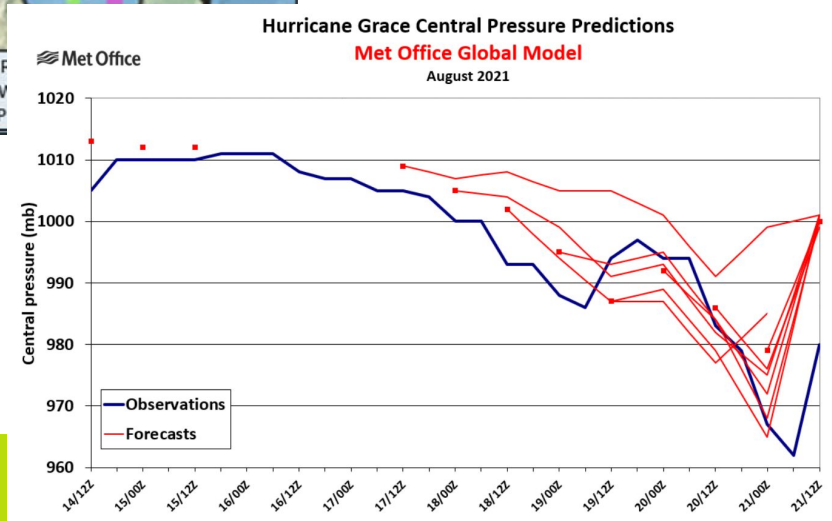
Hurricanes Elsa (left) and Grace (right)

- Met Office models good for track
- MOGREPS-G ensemble captured northwards turn a little earlier than deterministic
- Intensification phases not captured



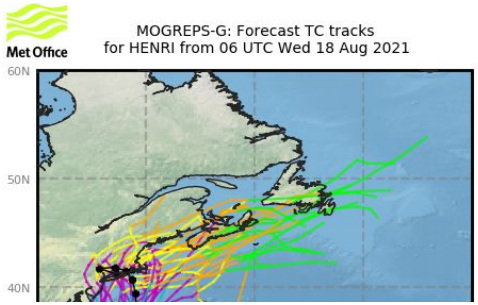
- Several MOGREPS-G ensemble members correctly predicted path across Yucatan into Bay of Campeche out to 6+ days, with confidence increasing over subsequent runs
- Intensification in Gulf of Mexico well predicted a couple of days ahead

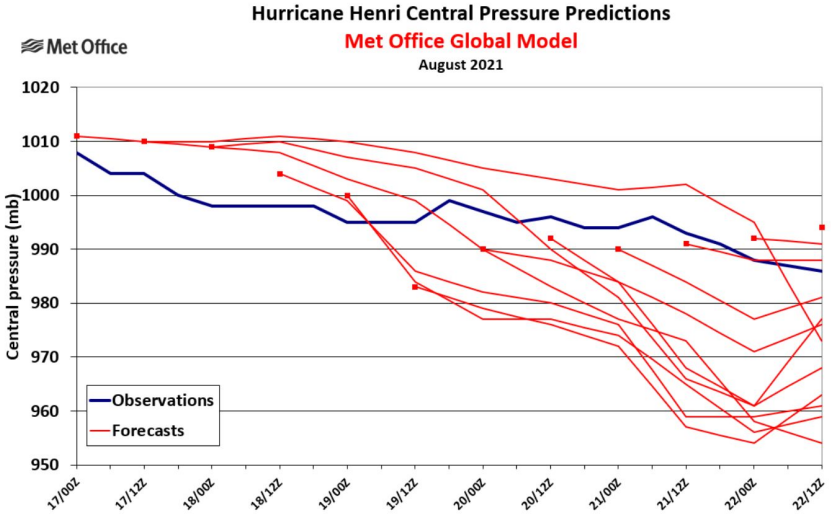




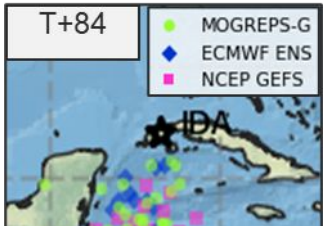
Hurricanes Henri (left) and Ida (right)

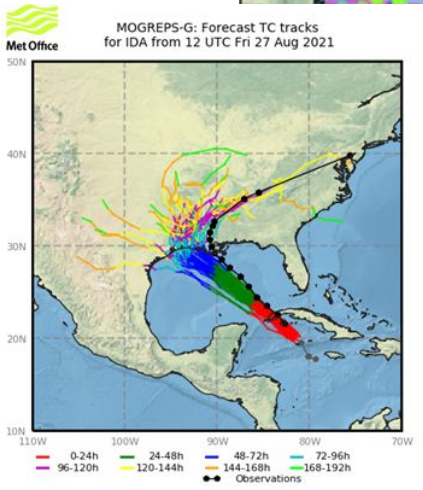
- Uncertainty in track captured by ensemble spread
- Over-intensification by deterministic model

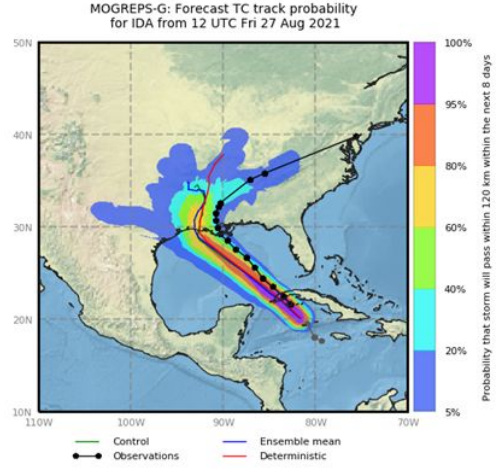




- Cyclogenesis poorly forecast in deterministic (> 48 h) and ensembles (> 72 h)
- Left bias in model forecasts, but spread covered track
- Forecast intensity too weak

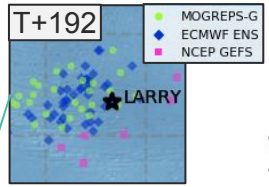


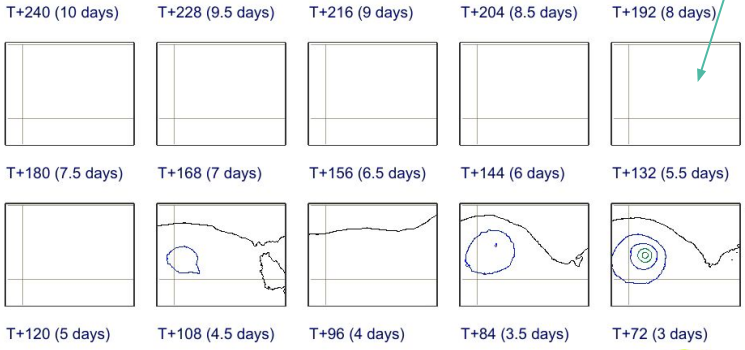




Hurricane Larry

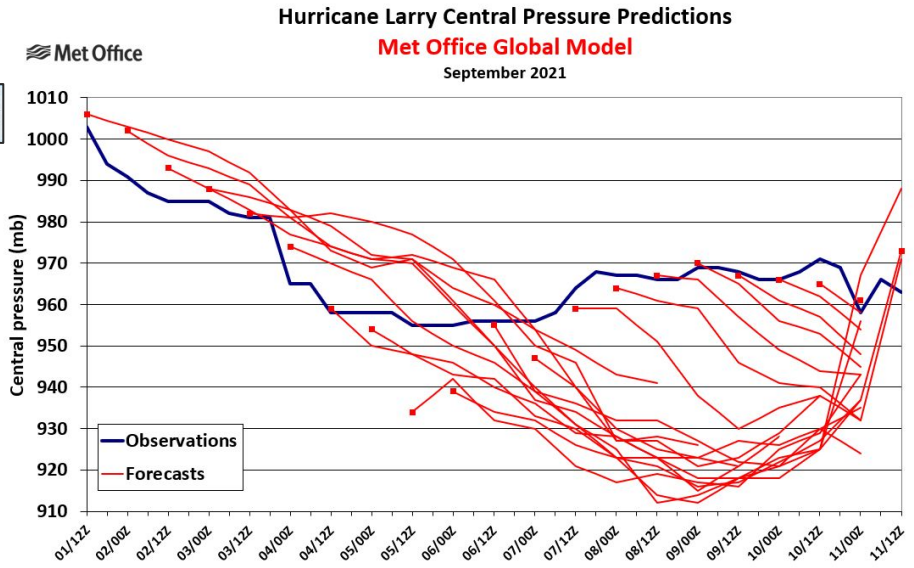
- Good for cyclogenesis
- Good for track
- Too weak in tropics, too strong in subtropics

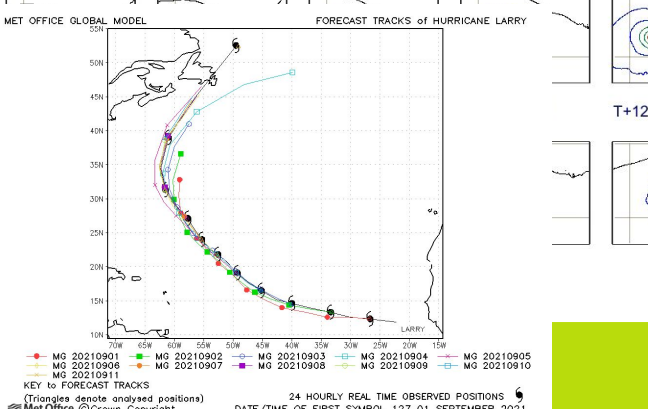


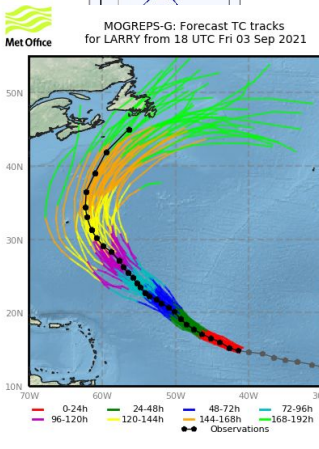


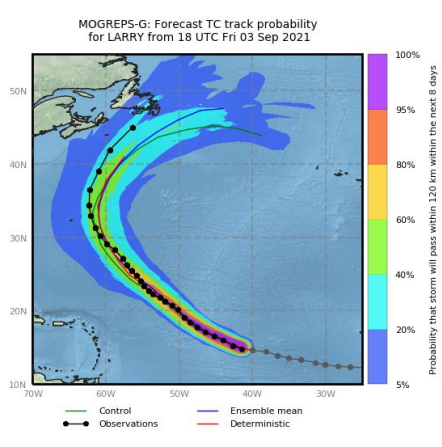
Met Office Global Model MSLP forecasts for Hurricane Larry valid at 12Z 02-09-2021 4mb contour interval blue <= 1012mb green <= 1004mb red <= 996mb

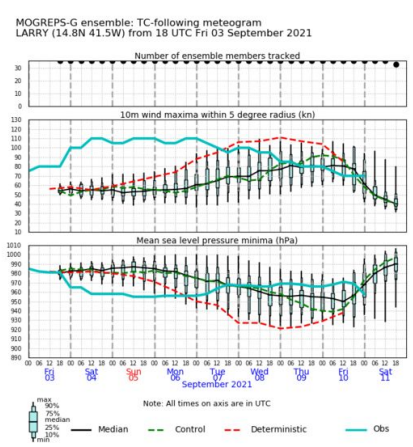
Met Office Global Model verifying analysis





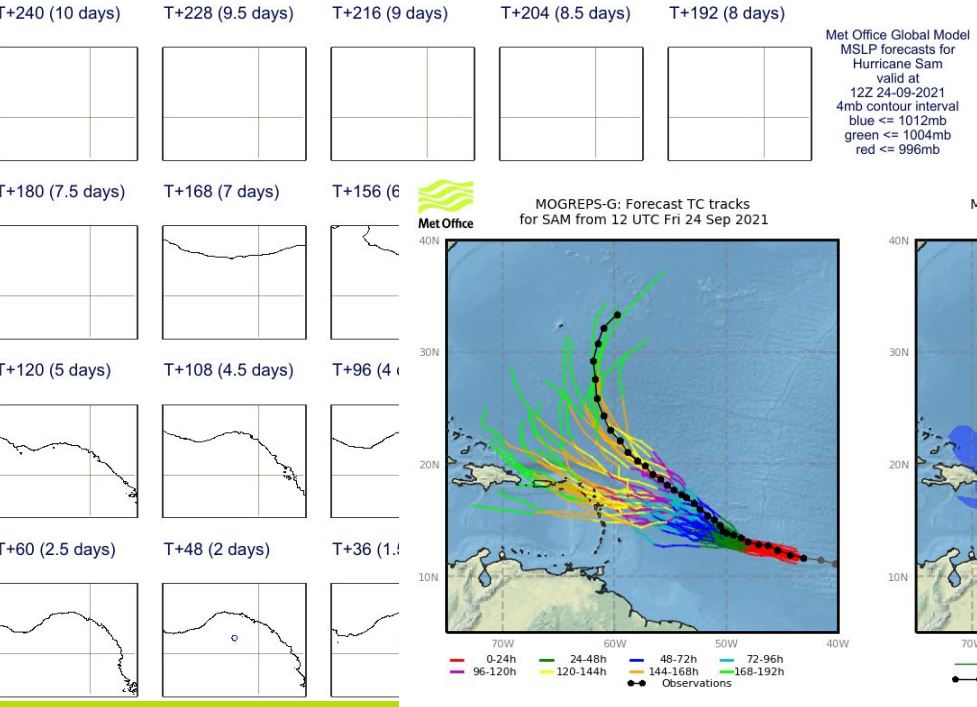


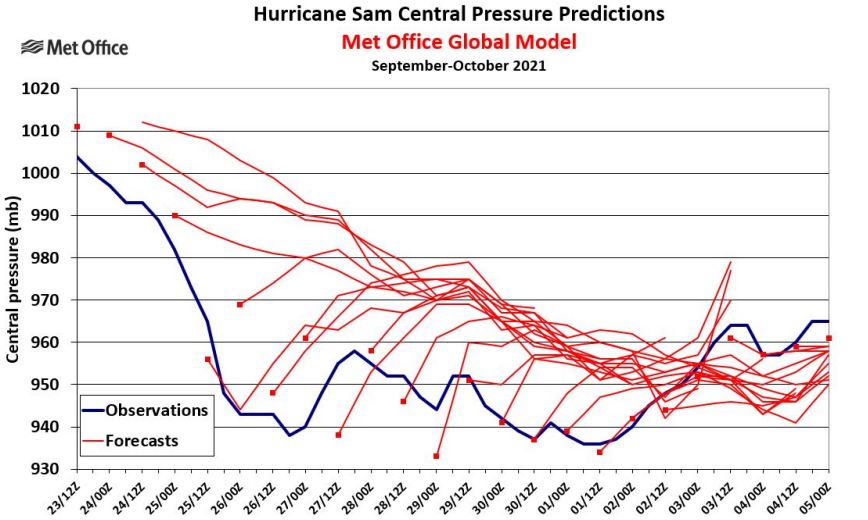


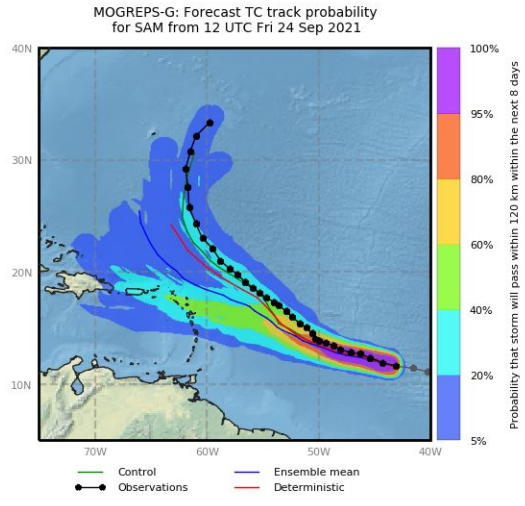


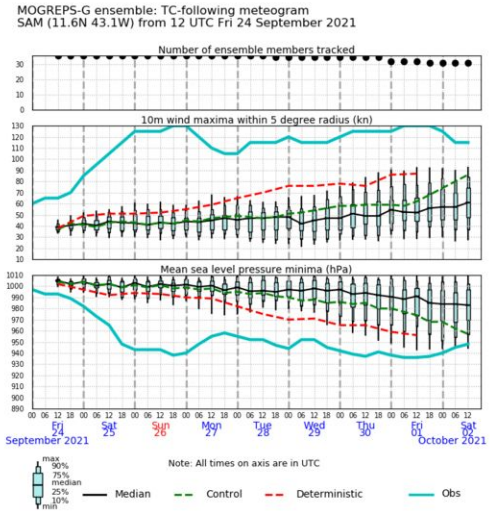
Hurricane Sam

- Small TC – weak cyclogenesis
- Left-of-track bias in models, but captured by ensemble spread
- Weak bias even into higher latitudes



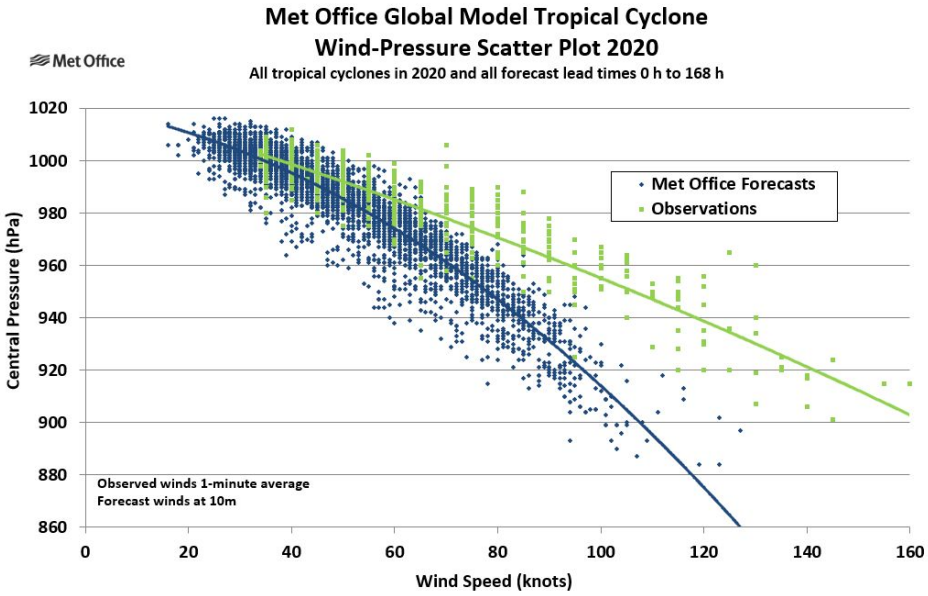


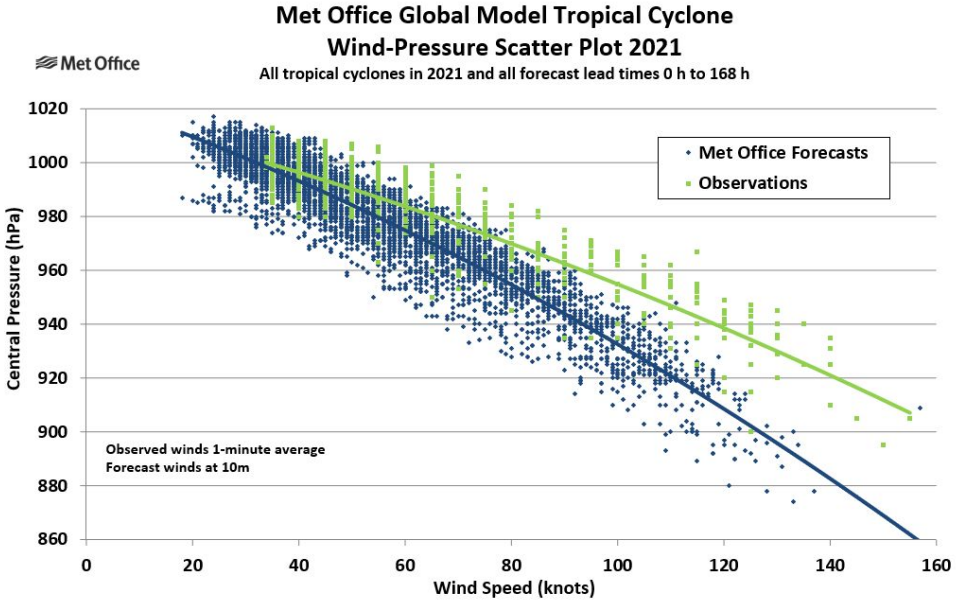




Wind-Pressure Relationship

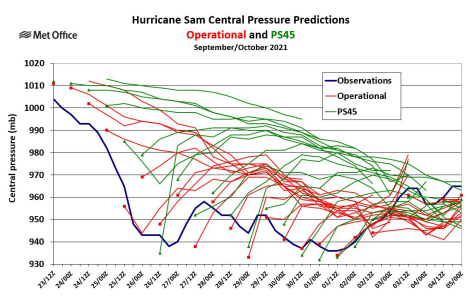
- Capped drag at high wind speeds implemented in global model late 2020
- Increases wind with no change in pressure for high wind speeds
- Clear improvement in wind-pressure relationship in 2021

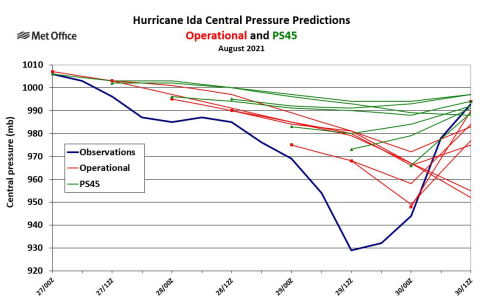


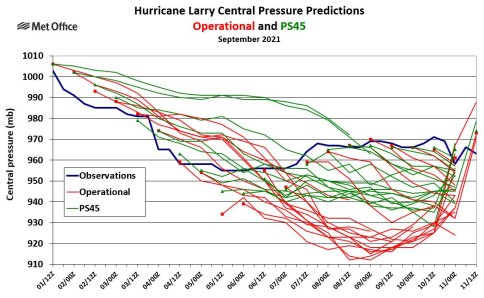


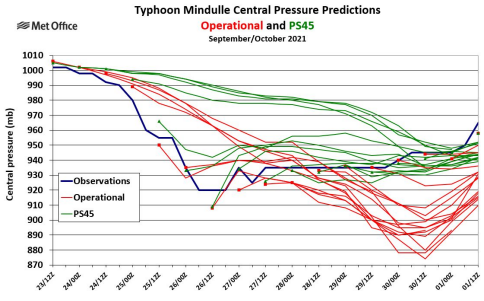
Model Change 15 March 2022

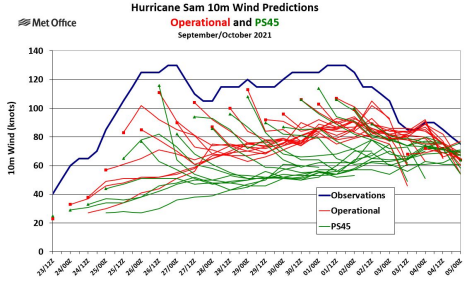
- Package of changes including ocean coupling and prognostic entrainment (convective memory)
- TCs systematically weaker, but reduces over-deepening in subtropics
- Impact on track is variable
- To be implemented 15 March 2022 due to overall positive impact on model forecasts
    - e.g. better organisation and timing of tropical precipitation

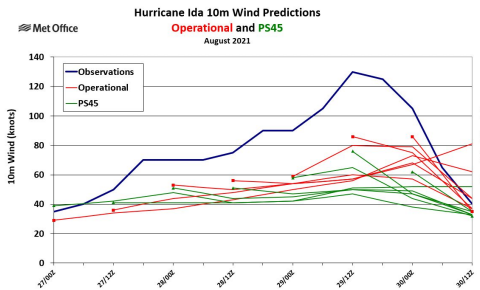


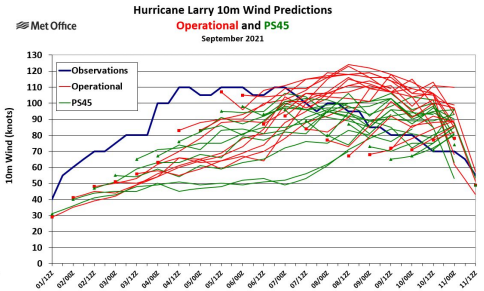


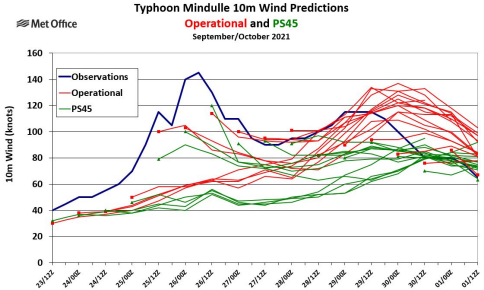






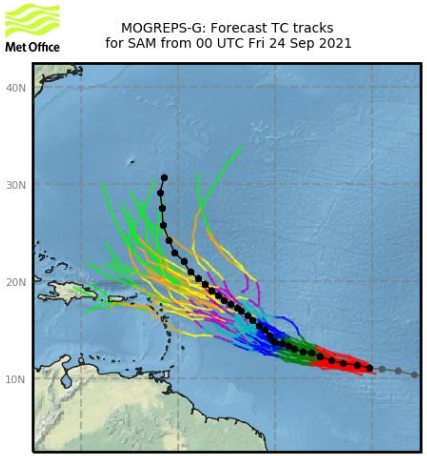


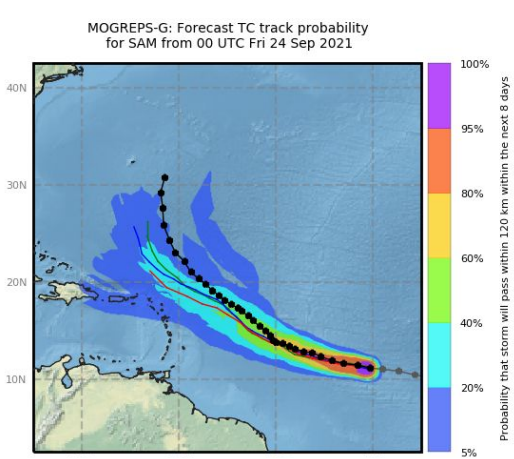


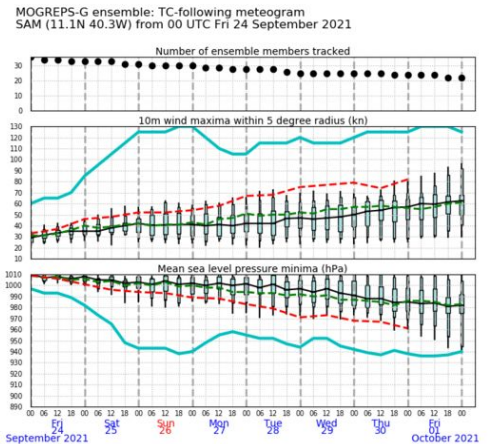


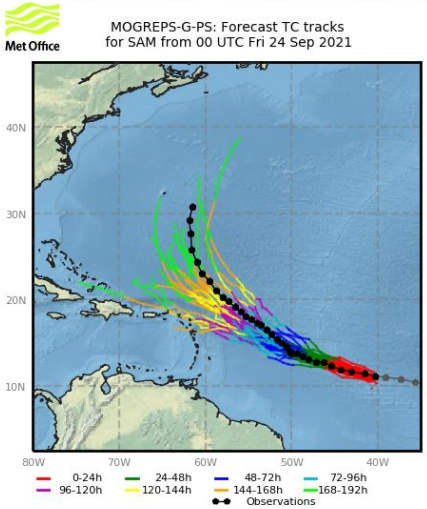
Model Change 15 March 2022

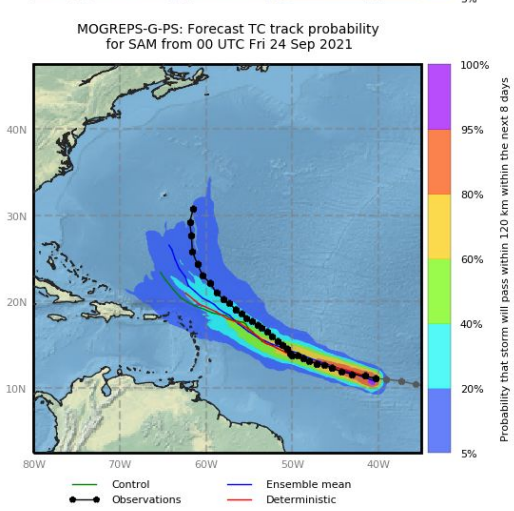
- Loss of intensity spread in MOGREPS-G ensemble, thought to be largely due to systematic weakening in the model
- Later delivery due to later data cut-off and stability enhancements
- Research project under way to investigate perturbing depth and position of TC observations to help improve ensemble spread

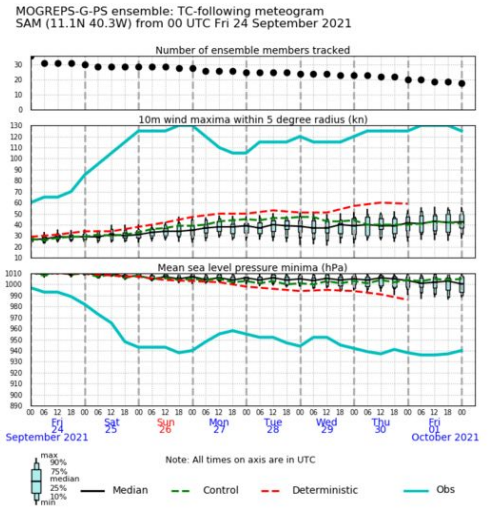






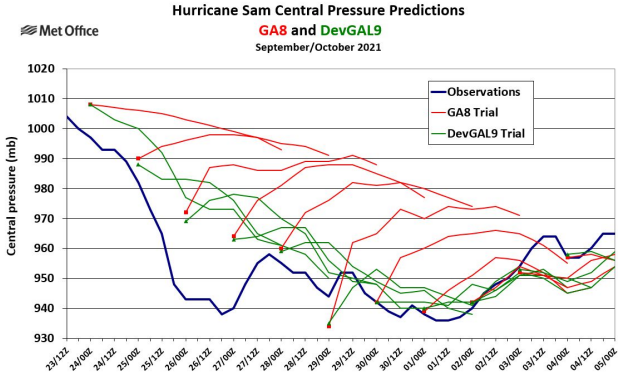


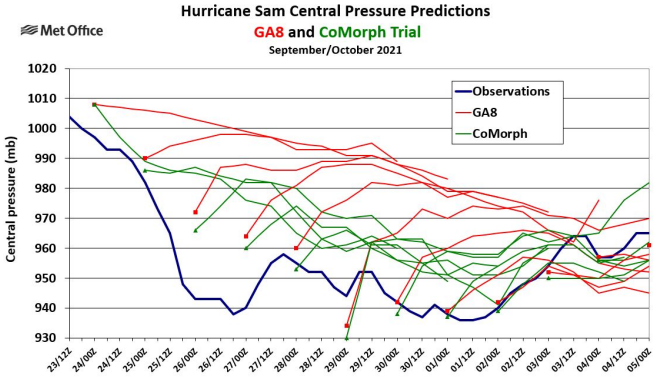


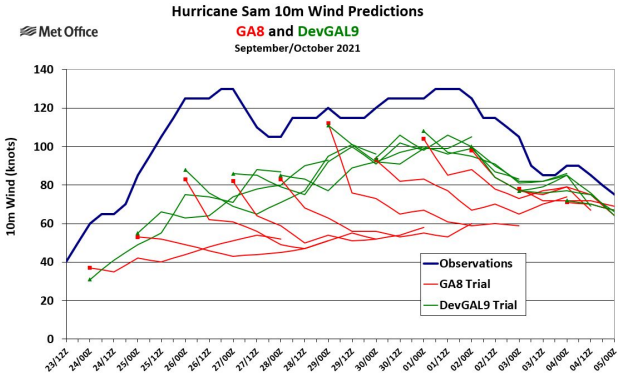


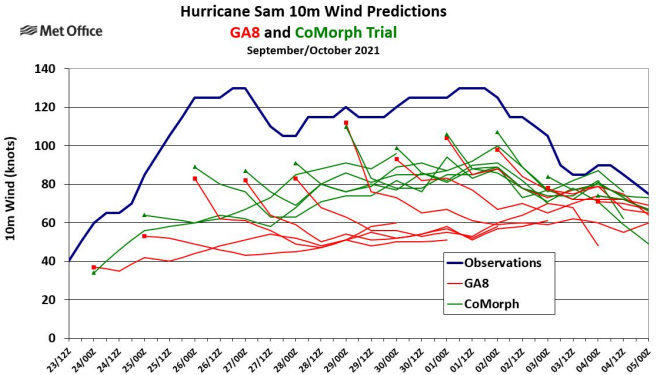
Future Model Developments

- Future changes already under development will reverse systematic weakening and reduce track errors
- Charts for Hurricane Sam compared with atmosphere only version of March 2022 configuration (GA8)
- DevGAL9 (left) – rely on mid-level convection and adjustment to convective detrainment
- CoMorph (right) – a new scale aware convection scheme
- Still much development and wider testing required, so cannot be implemented yet



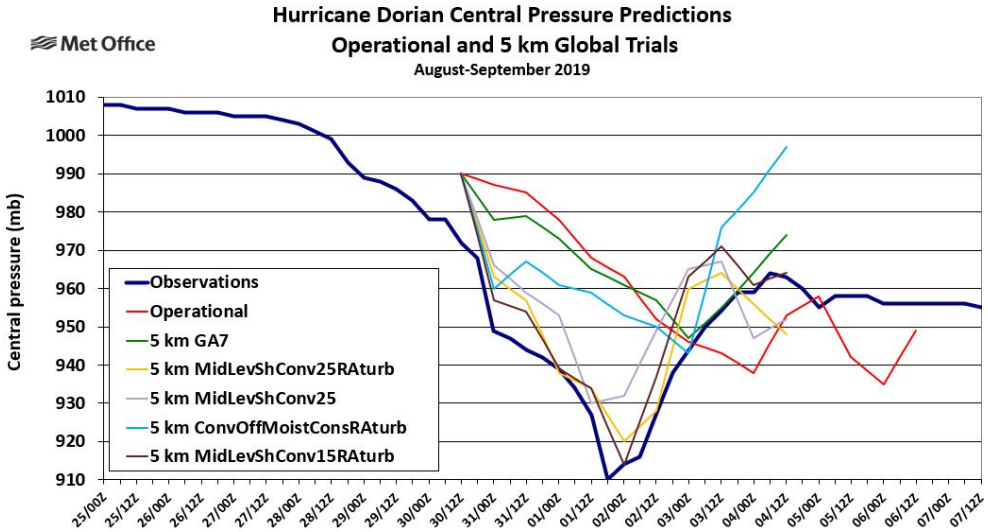


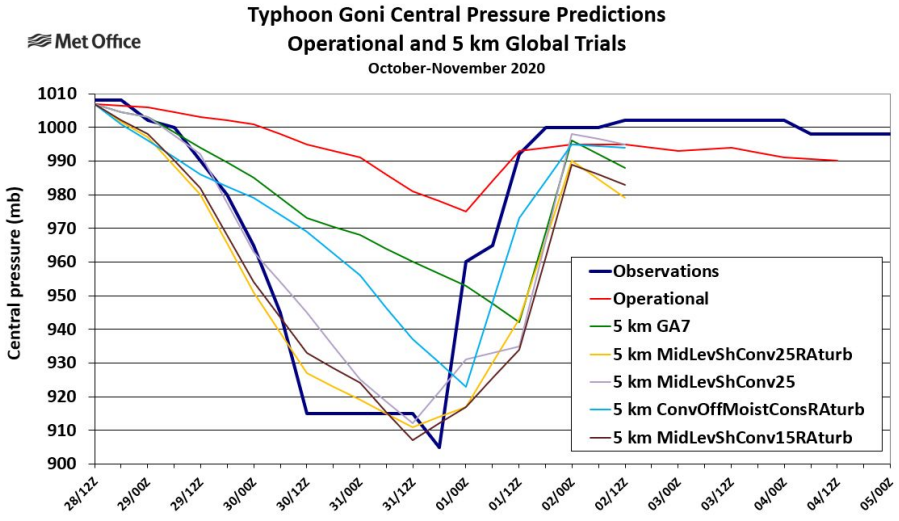




Future Model Developments

- Long term plans to run a 5 km resolution global model
- Experimenting with various science settings
- Hurricane Dorian and Typhoon Goni cases run
- Horizontal resolution not the biggest factor for intensity
- Adjustments to mid-level and shallow convection schemes and turbulence have bigger impact

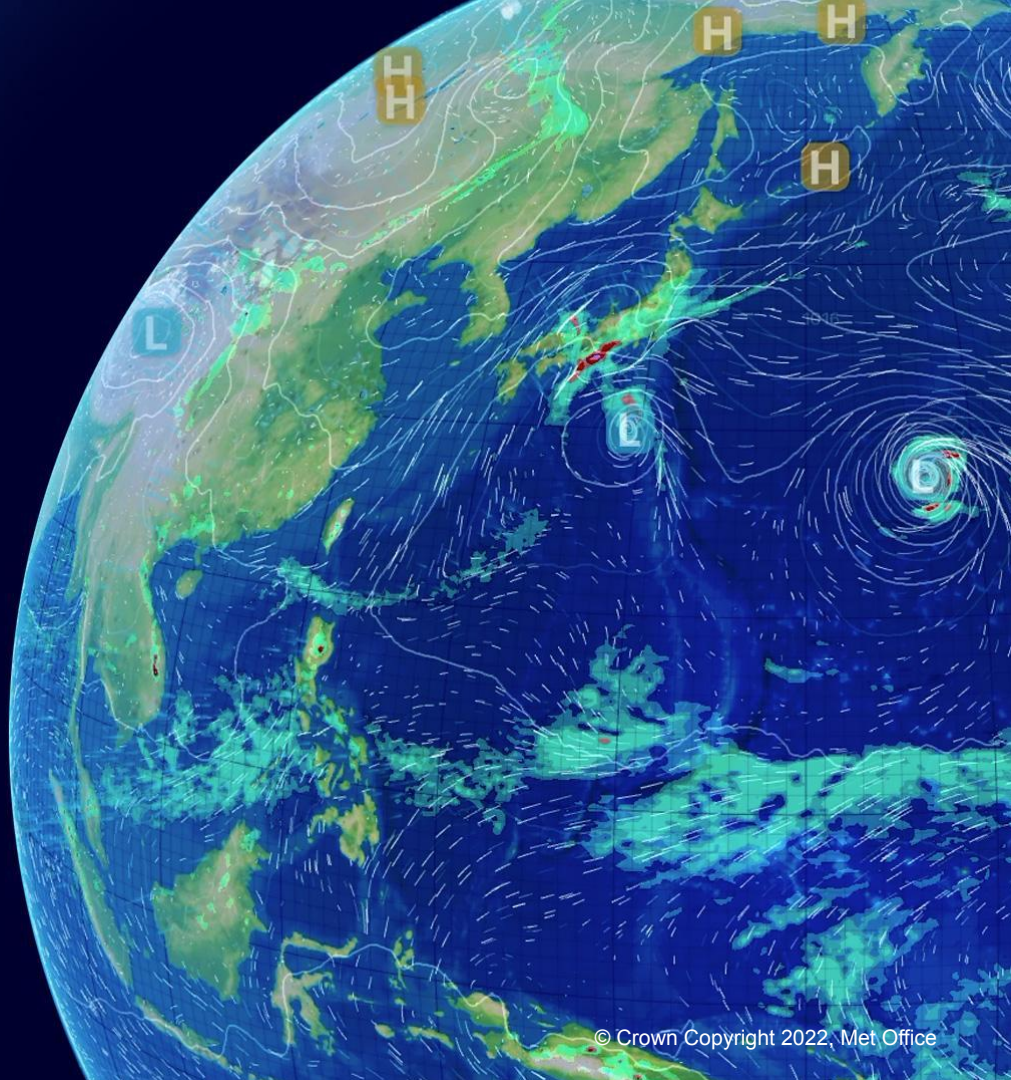




Summary

- Track forecasts good for longest lived TCs (Larry and Sam).
- Ensembles mostly captured tracks even for uncertain cases.
- Intensification not well captured for small TCs and those in deep tropics.
- As found in 2020, cyclogenesis better predicted in main development region than in the Caribbean and Gulf of Mexico.
- Upcoming model change will make TCs weaker – better in subtropics, but not in tropics. Ensemble spread decreased.
- Future plans for global model changes include physics changes, new convection scheme, increased horizontal resolution. All improve TC forecasts in early tests.

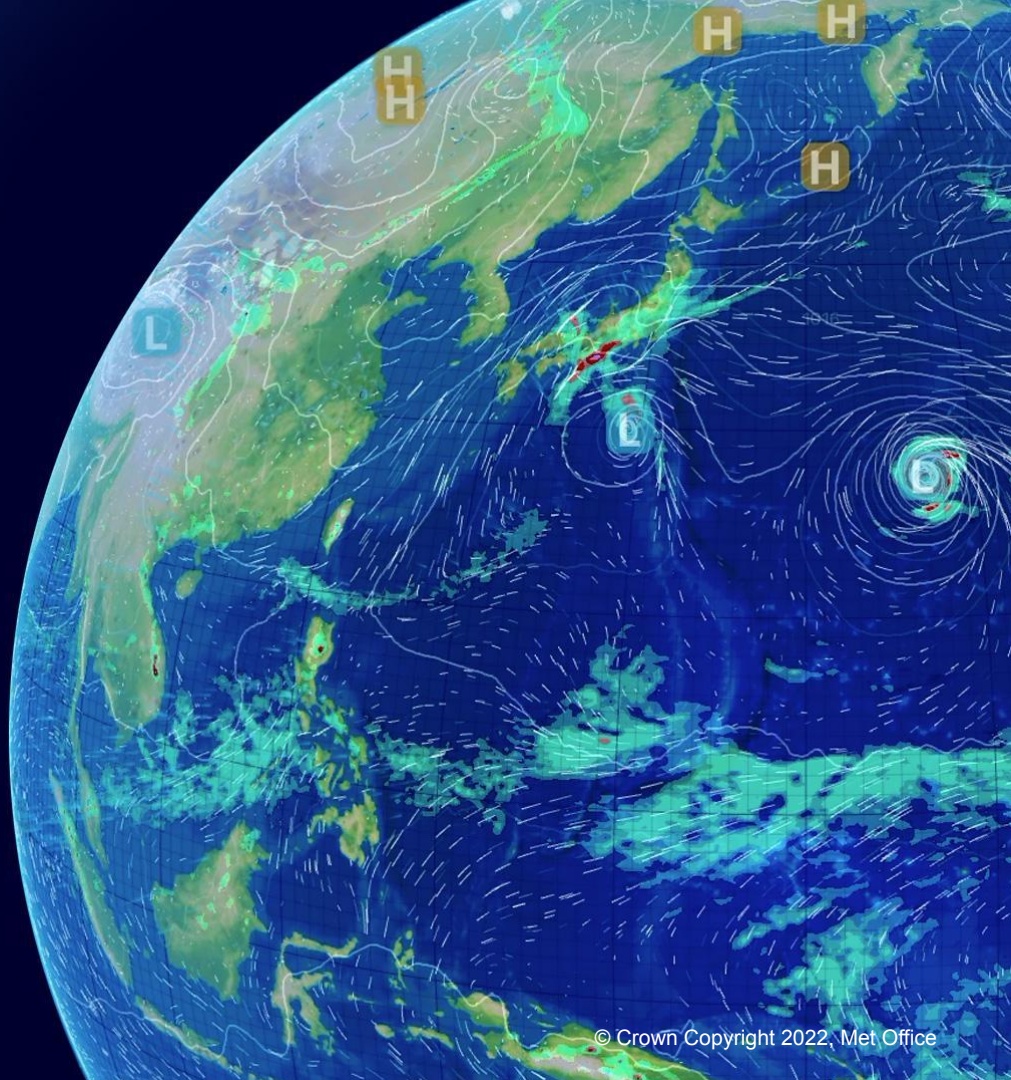
The End



© Crown Copyright 2022, Met Office

Met Office

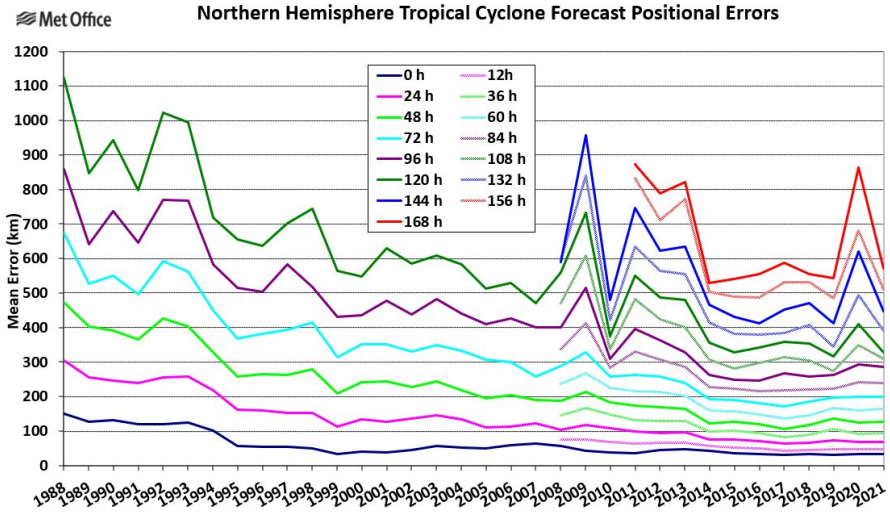
Additional slides showing more detail

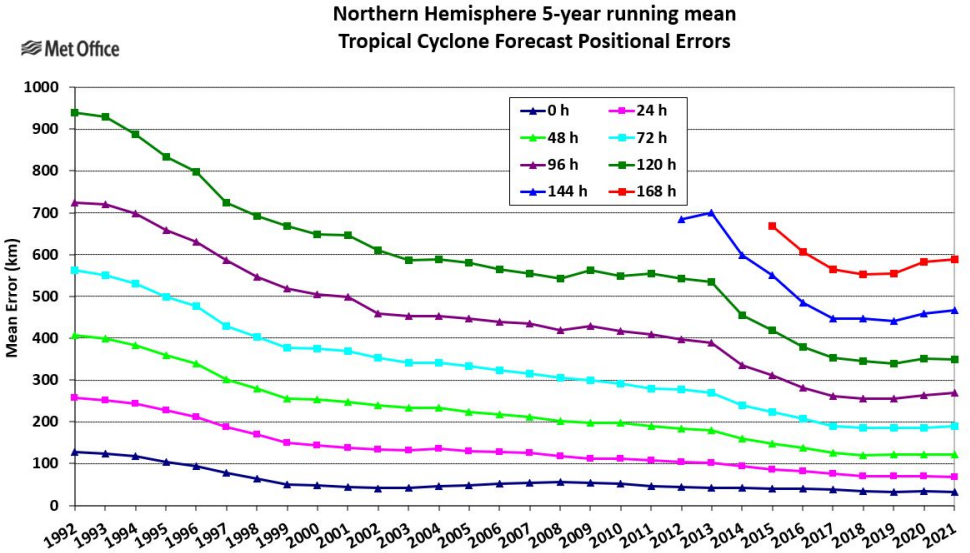


© Crown Copyright 2022, Met Office

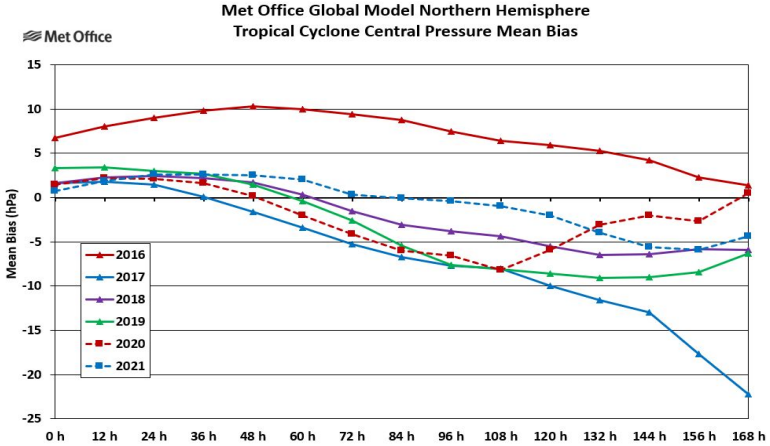
Global Model Performance 2021

- Northern hemisphere track error on lower than 2020
- Step reduction in 2014 now dropped out of 5-year running mean
- Recent model changes no significant impact on track error

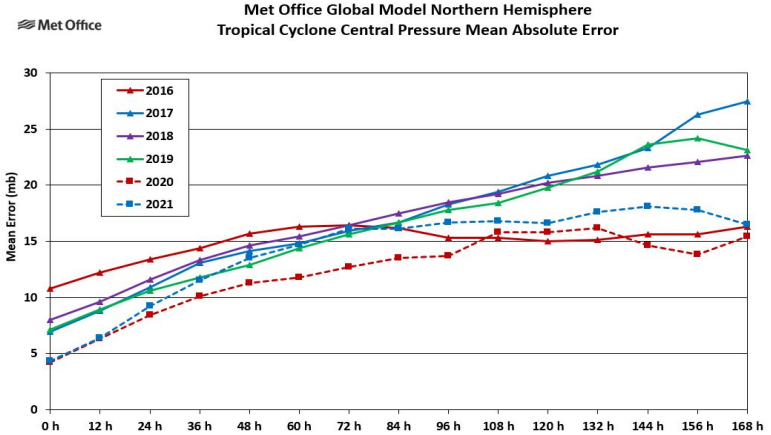




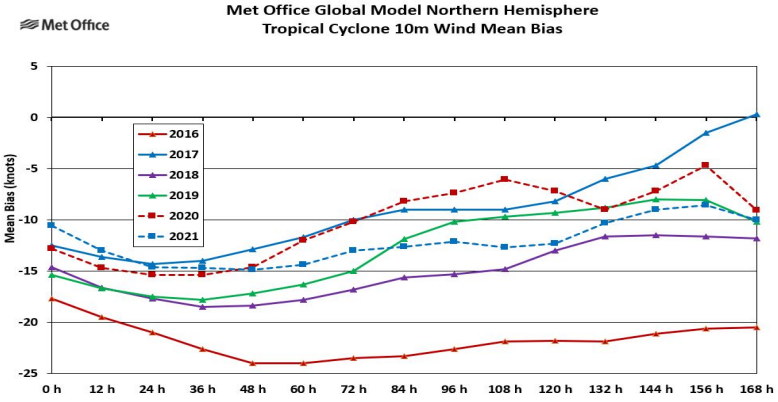
Global Model Performance 2021



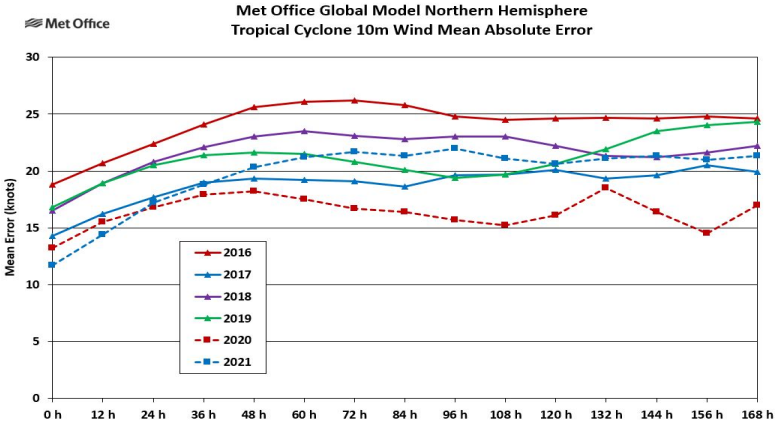
◀Pressure bias



Pressure absolute error▶



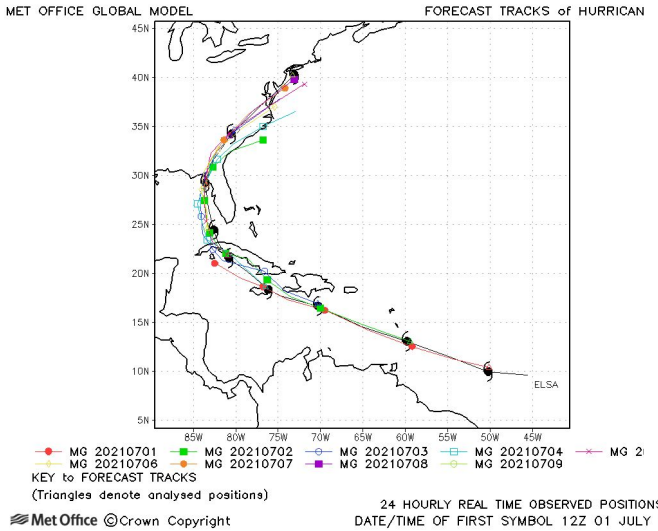
◀ Wind bias

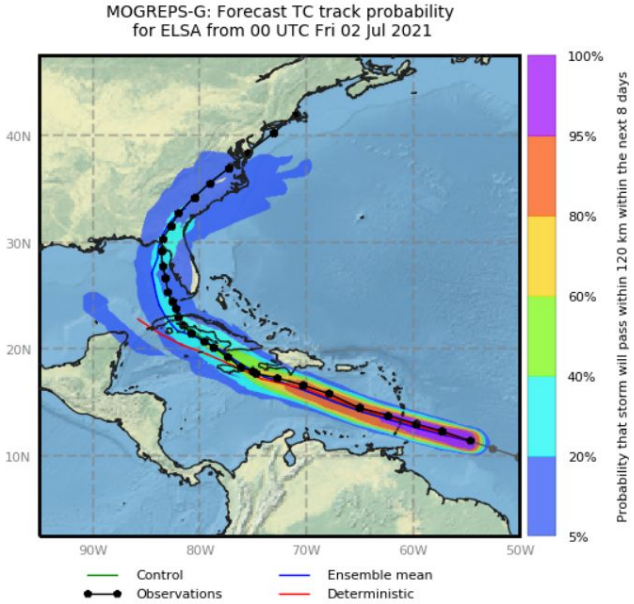


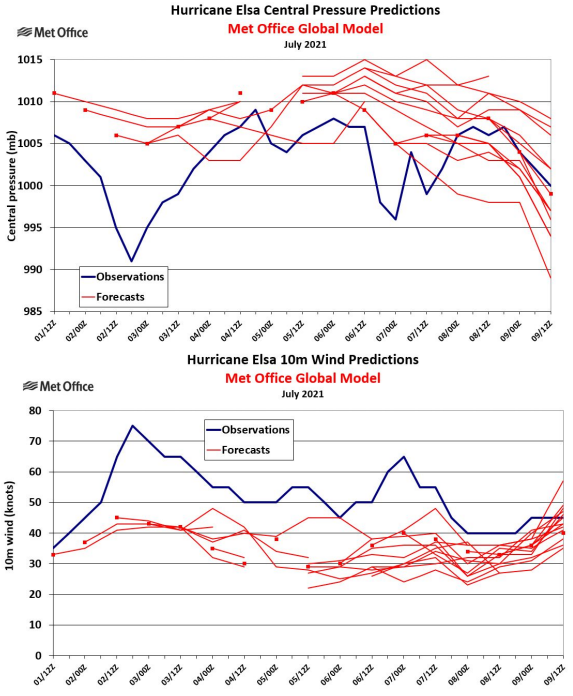
Wind absolute error ▶

Hurricane Elsa

- Met Office models good for track
- MOGREPS-G ensemble captured northwards turn a little earlier than deterministic
- Intensity forecasts mostly poor
- Intensification phases not captured

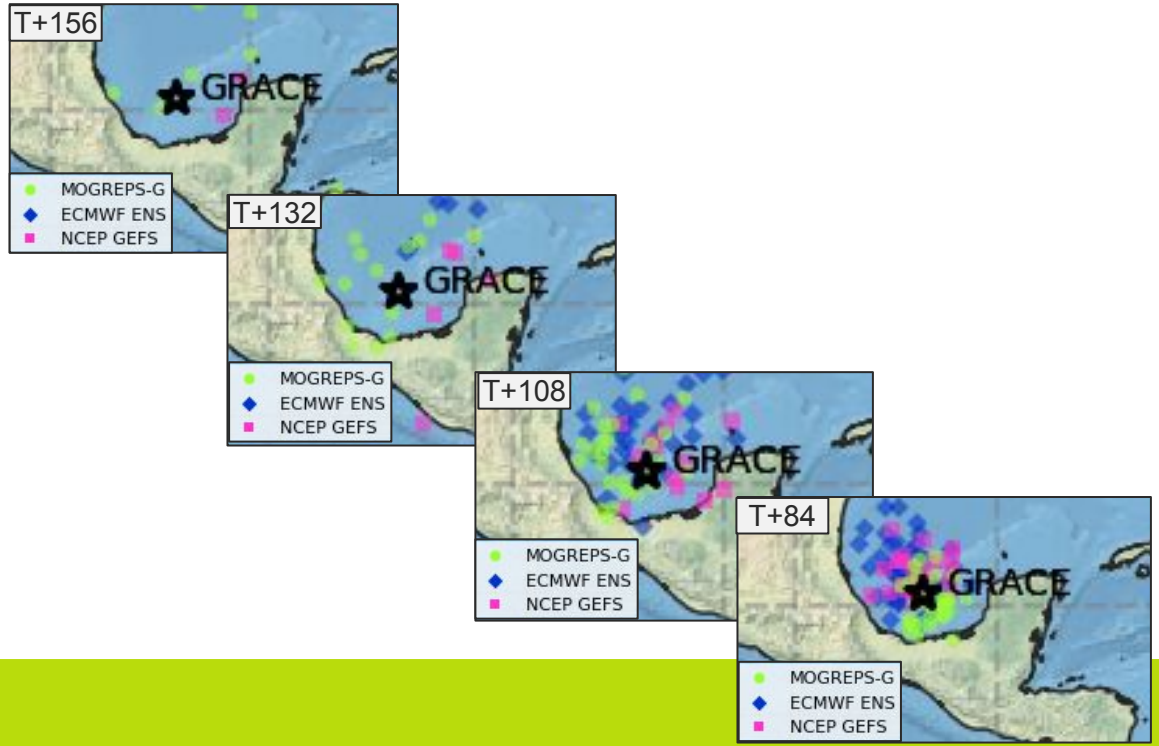


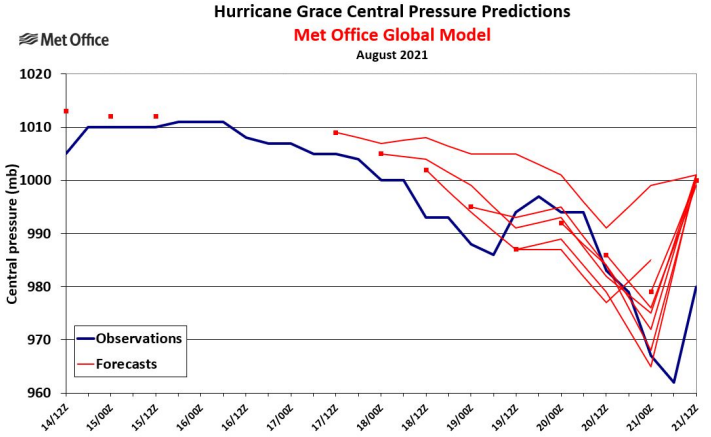


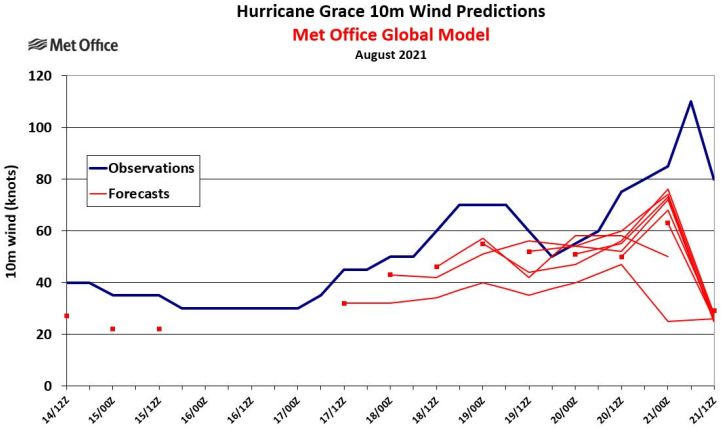


Hurricane Grace

- Several MOGREPS-G ensemble members correctly predicted path across Yucatan into Bay of Campeche out to 6+ days, with confidence increasing over subsequent runs
- Intensification in Gulf of Mexico well predicted a couple of days ahead

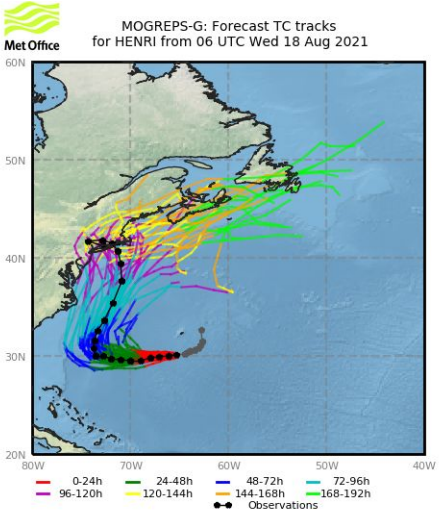


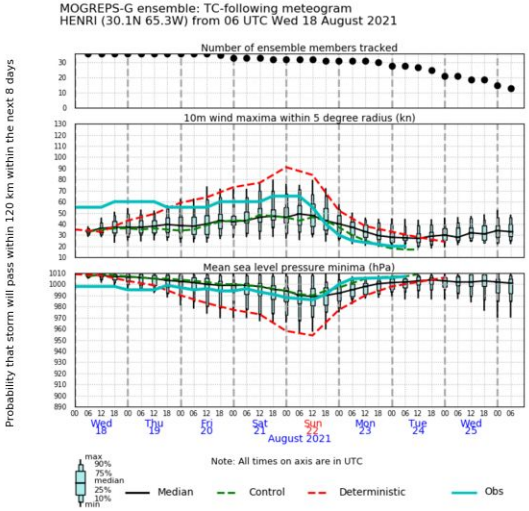


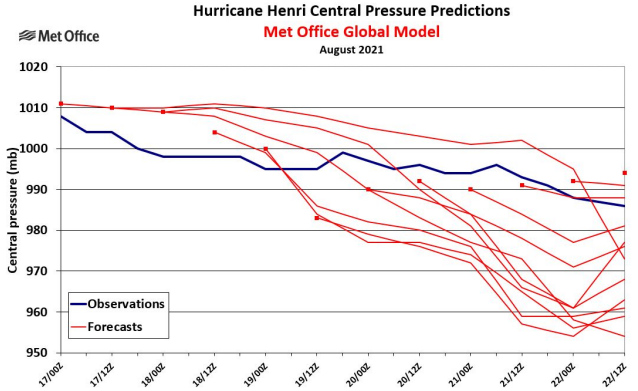


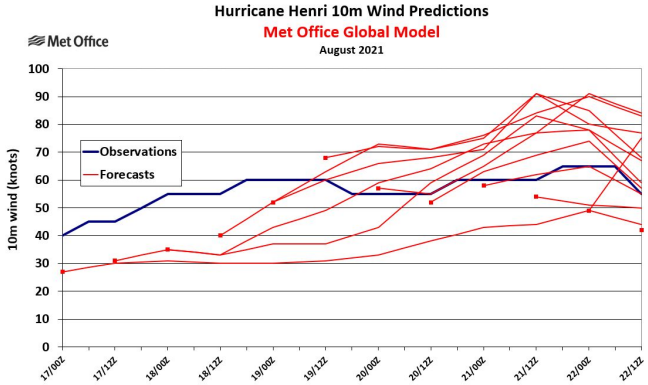
Hurricane Henri

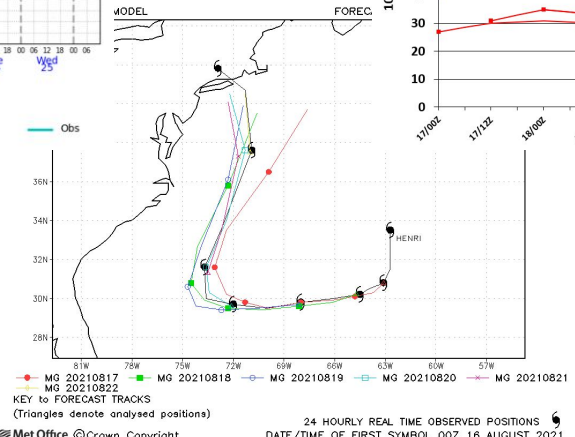
- Uncertainty in track captured by ensemble spread
- Over-intensification by deterministic model





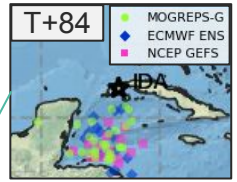
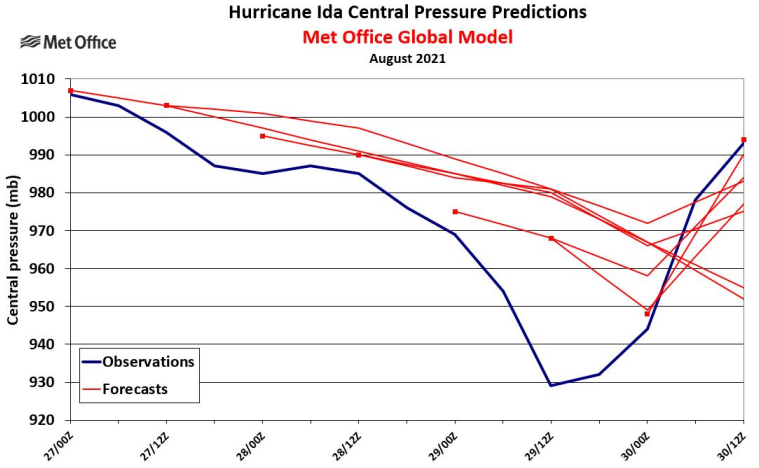
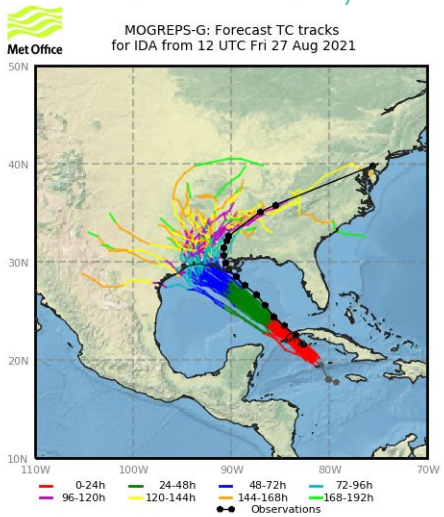
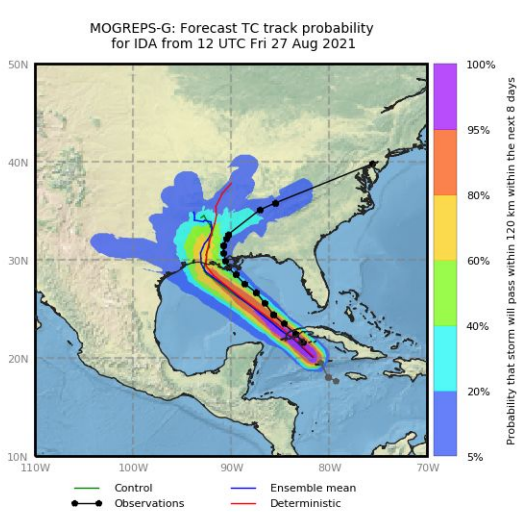
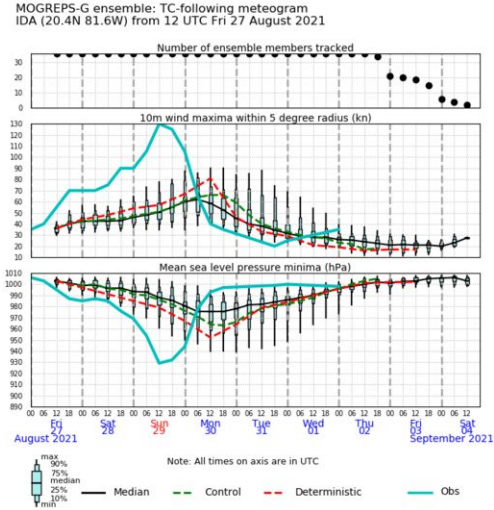






Hurricane Ida

- Cyclogenesis poorly forecast in deterministic (> 48 h) and ensembles (> 72 h)
- Left bias in model forecasts, but spread covered track
- Forecast intensity too weak



Met Office Global Model MSLP forecasts for Hurricane Ida valid at 00Z 28-08-2021 4mb contour interval blue <= 1012mb green <= 1004mb red <= 996mb